

24 of 24

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report  
of  
Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Paul Atwood Hervey for the degree of Master of Science. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science.

C. O. Rosendahl

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C. A. Morrow.

May 21 1918

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Examination

This is to certify that we the undersigned, as a committee of the Graduate School, have given Paul Atwood Harvey final oral examination for the degree of Master of Science . We recommend that the degree of Master of Science be conferred upon the candidate.

Minneapolis, Minnesota

May 11 1918

C. O. Rosendahl

Chairman

Fred K. Butters

C. A. Morrow.

A Morphological Study of the Receptacle of  
*Anemone patens* var. *wolfgangiana*.

A Thesis submitted to the  
Faculty of the Graduate School of the  
University of Minnesota

by

Paul Atwood Harvey

In partial fulfillment of the requirements  
for the degree of  
Master of Arts

June

1918

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Introduction.

The purpose of this paper is to add something to the knowledge of the phylogeny of the Ranalean forms by a study of the anatomy of the floral axis. *Anemone patens* var. *wolfgangiana* was chosen because of the large receptacle and because of its abundance and accessibility.

Material.

On Oct. 23, 1917 eight plants were transplanted from the Fort Snelling reservation to the University greenhouse where they were placed in pots and left out of doors until well frozen. On Nov. 10, 1917 several more plants were transplanted from the heights on the north side of the Minnesota River about five miles west of Fort Snelling. They were placed in "flats" and put out of doors to freeze, the object being to hasten the flowering period. As a result of experiments carried on during the seasons of 1912-13 and 1913-14 by Dr. C.O. Rosendahl it would seem that the stimulus of thorough freezing for several weeks is necessary to successful forcing of native perennials. (1)

Buds were fixed on both occasions. The buds collected from the heights above the Minnesota River were much larger and stronger appearing than those collected from Fort Snelling. The plants themselves were larger and stronger appearing, not having been trampled upon as much as those from the reservation had been.

None of the plants seemed to like the change. Only

(1). Rosendahl, C.O. *Plant World* 17, pp. 356-360. 1914.

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two flowers developed. They blossomed during the Christmas holidays, and were fixed in alcohol-acetic acid. By the first part of January almost all of the plants had developed leaves, and several buds gave evidence of awakening. Suddenly, however, the rooting systems began to shrivel, dry up, and decay. By the latter part of January practically all of the plants had dried up.

The buds which were collected on Oct. 23, 1917 and Nov. 10, 1917, the two flowers which blossomed during the Christmas holidays, formalin material, which had been collected April 21, 1914 from Fort Snelling, and flowers collected from Fort Snelling and Glenwood Park in the spring of 1918 constituted the material which was used in this study.

#### Technique.

Some of the buds collected Oct. 23 and Nov 10 were fixed in alcohol-acetic acid and some in Flemming's medium solution. The two flowers secured during the Christmas holidays were fixed in alcohol-acetic acid. The fixations in alcohol-acetic acid were very good for morphological study and for this reason nothing was done with the material fixed in Flemming's medium solution since it requires more time to handle. Some plasmolysis took place but even in the embryo sacs this was not marked. The latter would be excellent subjects for a cytological study on account of the large size of the nuclei.

The stain used was Haidenhain's Iron-Alum Haematoxylin. The cell walls stand out clearly and distinctly usually against the grayish-black of the protoplasts. This stain proved so satisfactory that no other was necessary, tho some material was stained with Safranin and Cyanin, and some with Safranin and Anilin

Blue.

Most of the sections were cut 10 micromes thick. If cut thinner than this they tended to break.

The flower.

The flower of *Anemone patens* var. *wolfgangiana* has six sepals which are in two whorls of three each. They are usually pale lavender in color, almost glabrous on the inside, but covered with a dense, light-grayish, silky pubescence on the outside. The peduncle and the involucre as well as the stem and the leaves are also covered with a similar pubescence. (Fig. 1.)

In the bud the receptacle is truncate-cylindric (Fig. 2.) As the flower develops the part of the receptacle above the sepals expands into a cushion-like ring which reminds one somewhat of the fleshy receptacle of the *Pomeae* except that it involves only that part of the receptacle which bears the stamens. (2) (Fig. 3.) This expansion is largely due to great increase in the cortical layer of this part of the receptacle. The cushion-like ring is very much like a similar structure in *Cycadeoidea* as described and figured by G.R. Wieland. (3)

In the bud this region is 10-12 cells thick; in the flower, 18-20. The expansion is partly due to an increase in the number of cells in this part of the cortical region, and partly to an increase in the size of the constituent cells. The tis-

(2). Kraus, E.J. Ore. Agricultural College Experiment Station, Research Bulletin No.1, Part 1, pp. 7-9. Pl.II. 1913.

(3). Wieland, G.R. American Fossil Cycads. Chps. VI and VII. 1906.

sue which forms the cushion-like ring becomes spongy in the flower. (Fig. 3.)

In the bud the carpels are borne on the truncated end of the receptacle (Fig. 2). In the flower this part of the receptacle becomes somewhat convex but there is no such increase in the thickness of the cortical region as in the portion which bears the stamens, and the tissue is not spongy. (Fig. 3)

#### Structure of the receptacle.

The epidermis of the receptacle consists of a single well-marked layer of cubical cells. The cortical parenchyma, in the mature flower, consists of cells which are more or less spherical in shape and comparatively small in the outermost portion, and are somewhat tangentially elongated toward the inside in the part of the receptacle which bears the carpels. (Fig. 3) The cells are usually radially elongated and spongy in nature in that portion of the receptacle which bears the stamens. (Fig. 3)

The parenchyma of the pith is distinctly spongy in the center and is made up of elongated cells. Toward the outside of the pith the lysigenous cavities are very small and the cells are small, spherical, and compact. (Fig. 4)

Between the cortical parenchyma and the pith the vascular system forms a ring of from 30 to 55 bundles, from which branches are sent to the stamens and carpels. (Fig. 4)

#### The nodal anatomy of the involucre.

Below the involucre there are usually 34 bundles in the peduncle, nine of which pass to the three involucreal leaves. The supply of each of the leaves is, therefore, trilacunar.

E.W. Sinott (4) by a comparative study of various genera of the Ranales has come to the conclusion that the trilacunar node is primitive in this group. But he finds that in certain of the higher forms, of which Anemone is one, the supply to the foliage leaves is multilacunar. The retention of the trilacunar supply for the involucral leaves, borne high upon the floral axis is an interesting instance of conservation of the vascular structure of the floral axis.

The vascular system in the receptacle.

The number of bundles in the peduncle below the calyx node is from 18 to 25. About half of these are large bundles and about half are small ones. Usually there is one less of the small bundles than of the large ones. Just below the calyx node they branch. The large bundles form two, three, or four branches; the small ones, two. Several contiguous bundles supply the sepals, in what manner I am unable to say at present.

All of the bundles which appear above the sepals continue their course to the top of the receptacle where each ends in a carpel. They do not reunite at the top of the receptacle.

The method of branching in the receptacle.

During the course of a single bundle thru the receptacle it sends branches to a number of stamens and carpels. (Figs. 5a, 5b, and 5c.) The vascular supply to each stamen and carpel originates as a single lateral branch from one of the bundles in the receptacle. This method of branching which is corroborat-

(4). Sinott, E.W. American Journal of Botany, p. 312, 1914.



ed in all of the material that has been examined, is peculiar in that no foliar gaps occur. A similar method of branching has been observed in the carpellate cone of *Zamia*.

As reported by A.J. Eames in 1916 before the American Association for the Advancement of Science, *Magnolia* shows a vastly more complex origin of the vascular supply in the receptacle than *Anemone*. The vascular supply for the carpels and the stamens, which is so complex in *Magnolia*, is very simple in *Anemone*.  
The structure of the bundle in the receptacle.

The bundle in the receptacle is distinctly collateral. It is endarch with a distinct but comparatively inextensive protoxylem. The phloem is extensive. Even at the time of anthesis, there is a large amount of undifferentiated tissue present between the phloem and the protoxylem. (Fig. 6) This probably becomes metaxylem during the ripening of the fruit.

The course of a bundle in the stamen.

The course of a bundle in the stamen is very simple. A branch from one of the main bundles in the receptacle passes directly thru the cushion-like ring to which the stamens are attached (Fig. 3) up the center of the filament, <sup>and the anther</sup> without branching. (Fig. 11). The bundle is collateral endarch.

The course of a vascular bundle in the carpel.

As with the stamen, the course of a vascular bundle in the carpel is very simple. A branch from a main bundle in the receptacle passes directly thru the narrow cortex (Fig. 3) and to the top of the stipe of the carpel where it branches dorsiventrally. One branch passes up the abaxial side of the carpel

to the top of the stipe. The other branch runs up the wall of the ovary to the base of the funiculus of the ovule where it bends sharply, passes thru the funiculus, and ends in the chalaza end of the ovule. (Figs. 7 and 8). So far as observed it does not proceed at all into the integuments. As in the bundles of the receptacle, the bundle and its two branches in the carpel are distinctly collateral endarch. Altho the adaxial bundle presumably represents the two marginal veins of the carpellary leaf no evidence of double structure has been found.

All parts of the carpel and ovule are very clear and distinct with the exception of the inner integument. This apparently consists of but a single layer of cells. (Fig. 7).

One of the interesting things, regarding the carpel, is the numerous hairs which are outgrowths of the individual cells of the epidermis. They have a comparatively thick, very tough wall, (Fig. 10) and large, conspicuous nuclei. They form a dense protective covering from almost the base of the stipe, where they are short, to the top of the style where they are quite long. With the hairs of adjacent carpels they form a dense, tangled mass which in cross-section resembles parenchymatous tissue. (Figs. 9 and 10).

A cross-section thru several stipes and the surrounding masses of hairs resembles somewhat the cross-section thru the seeds and interseminal scales of Cycadeoidea as described and figured by G.R. Wieland. (5).

Summary.

In the flower of *Anemone patens* var. *wolfgangiana* the stamens are borne on a cushion-like ring which is the expanded portion of the receptacle immediately above the sepals. The carpels are borne on the convex end of the receptacle in the flower.

Below the involucre there are usually thirty-four bundles in the peduncle, nine of which pass to the three involucral leaves.

There are from 18-25 bundles in the peduncle below the calyx node. About half of them are large bundles and about half are small ones. Just below the calyx node they branch. Several contiguous bundles send branches to the sepals, and the rest, from 30-54, continue their course to the top of the receptacle, where each ends in a carpel.

The vascular supply to each stamen and carpel, with the exception of the carpels in which the main bundles of the receptacle end, originates as a single lateral branch from one of the bundles in the receptacle.

The bundles in the receptacle, and in the stamens and carpels are collateral endarch.

The course of the bundles in the stamens is simple and in the carpels they fork dorsiventrally at the top of the stipe.

I am very much indebted and grateful to Dr. C.O. Rosendahl and Dr. F.H. Butters for suggestions and helpful criticism in the preparation of this paper; and to E.A. Cuzner for the care of greenhouse material.

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Explanation of Plates.

Fig. 1. A flower with three sepals and some of the stamens and carpels removed.

Fig. 2. A longitudinal section, in outline, of a bud showing the truncate-cylindric receptacle.

Fig. 3. A longitudinal section of the receptacle of a flower (partly diagrammatic) showing the cushion-like ring and the convex top.

Fig. 4. A cross-section of the receptacle thru the cushion-like ring to which the stamens are attached (partly diagrammatic).

Figs. 5a, 5b, 5c. A series of figures to show the method of branching from a main bundle in the receptacle; 5a from the lower side, 5b in the middle, and 5c from the upper side of a branch at the point where it leaves the main bundle. This branch goes to a stamen.

Fig. 6. A cross-section of a <sup>with</sup> bundle in the receptacle.

Fig. 7. The course of a bundle in the carpel (partly diagrammatic).

Fig. 8. A cross-section of a carpel cut obliquely thru the funiculus about opposite the microphyllar end and passing thru the chalaza.

Fig. 9. A longitudinal section showing the dense tangle of hairs and several carpels.

Fig. 10. A cross-section of a mass of hairs and several carpels showing the tissue-like appearance of the former.

11.

Fig. 11. The course of a bundle in the stamen (partly diagrammatic).



Diagram of flower bud showing the base of the flower and the position of the stamens and carpels.

Fig. 1

*Hyacinthaceae* *potamo* var. *wolfgangiana*  
4-7-2-10-1921  
5/4/2



longitudinal section in outline of a bud showing the transverse-cylindrical receptacle

Fig. 2



*Anemone patens* var. *wolfgangiana*

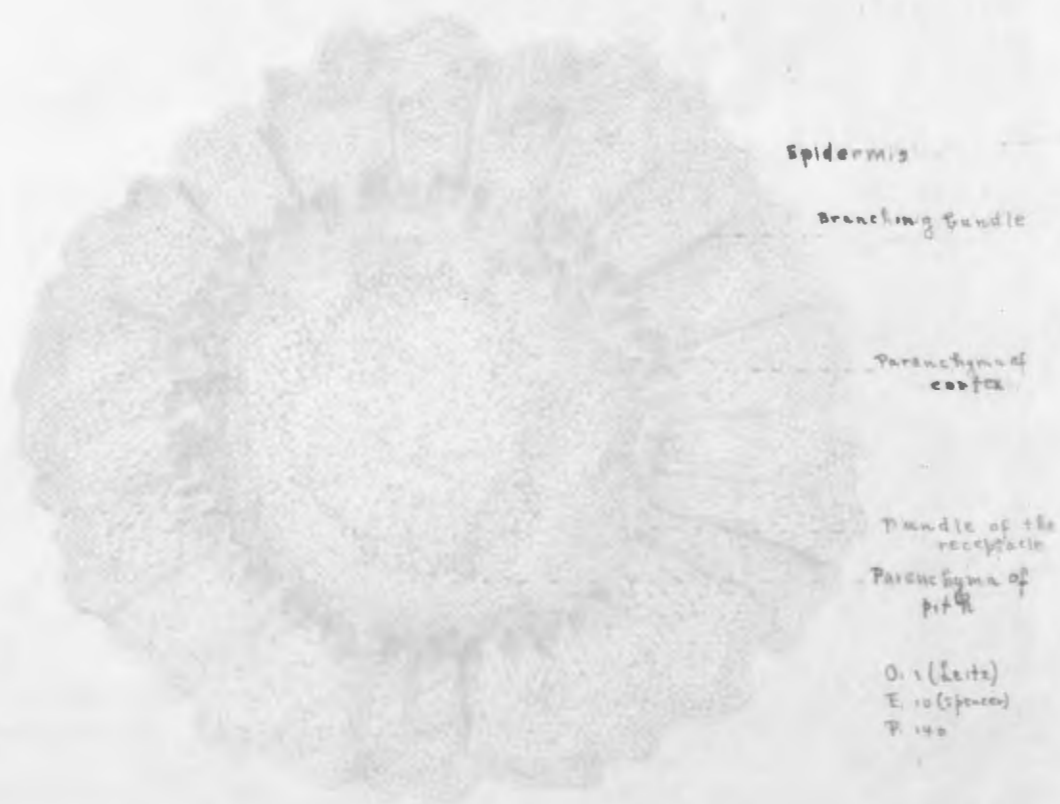
7-2-1-13-15-5

5/4/18



Longitudinal section of the receptacle of a flower (partly diagrammatic).  
Fig. 2 showing the cushion-like ring and the convex top

*Anemone patens* var *wolfgangiana*  
7-1-1-31-15-6  
4/20/5



Epidermis

Branching Bundle

Paracymbium of  
cortex

Bundle of the  
receptacle

Paracymbium of  
pith

O. 1 (Leitz)

E. 10 (Spencer)

P. 140

Cross-section of the receptacle (partly diagrammatic)

Fig. 4

*Hemone patens* var. *wolfgangii*  
7-1-1-2-5-1  
3/5/18

Section of a branching  
bundle

Modified parenchyma cells  
below branching  
bundle

Section of main  
bundle

Phloem of main bundle

Undifferentiated  
tissue

Protylem of  
main bundle

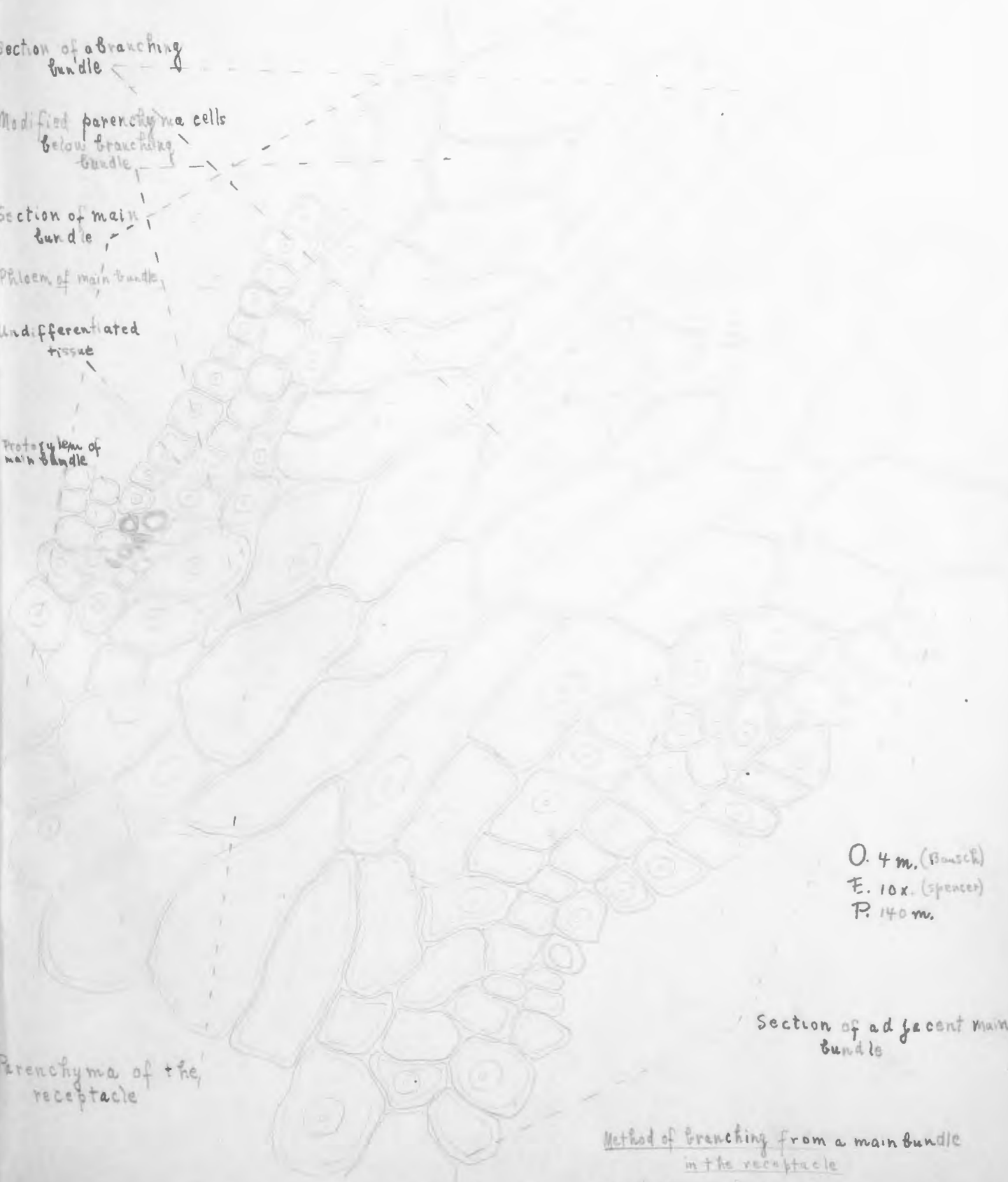
O. 4 m. (Bausch)  
E. 10x. (Spencer)  
P. 140 m.

Section of adjacent main  
bundle

Parenchyma of the  
receptacle

Method of branching from a main bundle  
in the receptacle

Fig. 5a (first in series)



*Anemone patens* var. *wolfgaugiana*

7-1-1-32-15-2

2/20/18

Phloem of  
Main bundle

Phloem of  
Branch

Section of  
Main bundle

Branching  
bundle

Undifferentiated  
tissue

Protylem of  
main bundle

Protylem of  
branch

Parenchyma of the  
Receptacle

Section of an adjacent  
Main bundle

O. 4 m. (Bausch)

E. 10 x (Spencer)

R. 140 m.

Method of branching from a main bundle in the receptacle

Trace (conduct. tissue)

*Hemerone patens* var. *wolfgangiana*  
7-1-1-32-15-31  
5/1/18

Section of branching bundle

Section of main bundle

Phloem of main bundle

Undifferentiated tissue

Protoylem of main bundle

Parenchyma of receptacle

Section of an adjacent main bundle

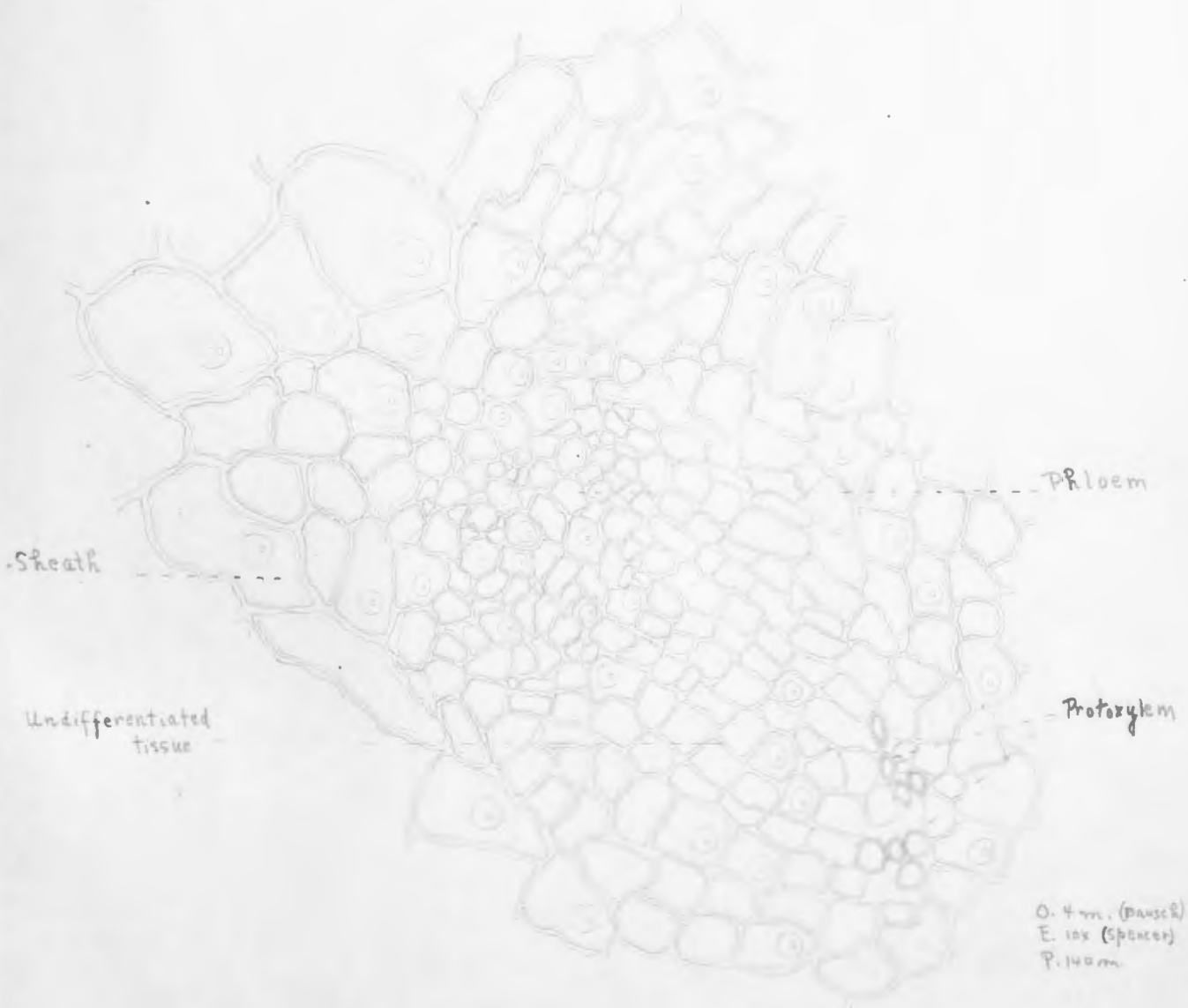
O. 4 m. (Bausch)

E. 10x (Spencer)

P. 140 m.

Method of branching from a main bundle of the receptacle

Fig. 5c (third series)



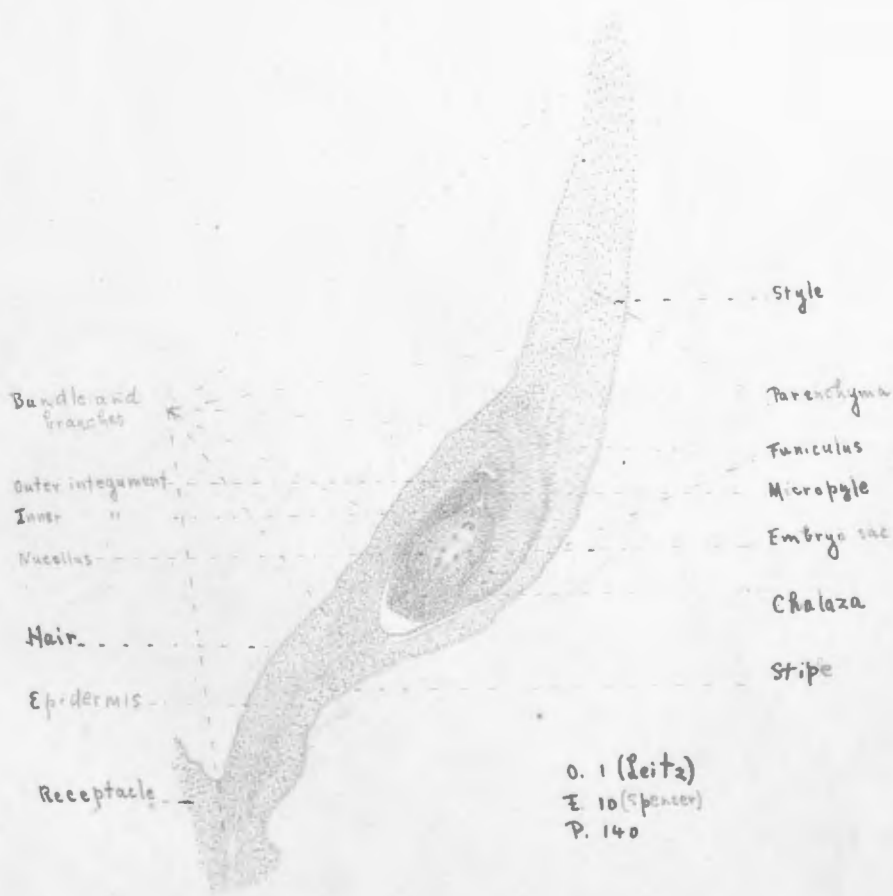
O. 4m. (Pansch)  
E. 10x (Spencer)  
P. 140m

Cross-section of a main bundle in the receptacle

Fig. 6

*Anemone patens* var. *wolfgangiana*

7-2-1- -15-3  
4/27/18



The course of a bundle in the carpel (long. section)  
Partly diagrammatic

Fig. 7

*Anemone patens*

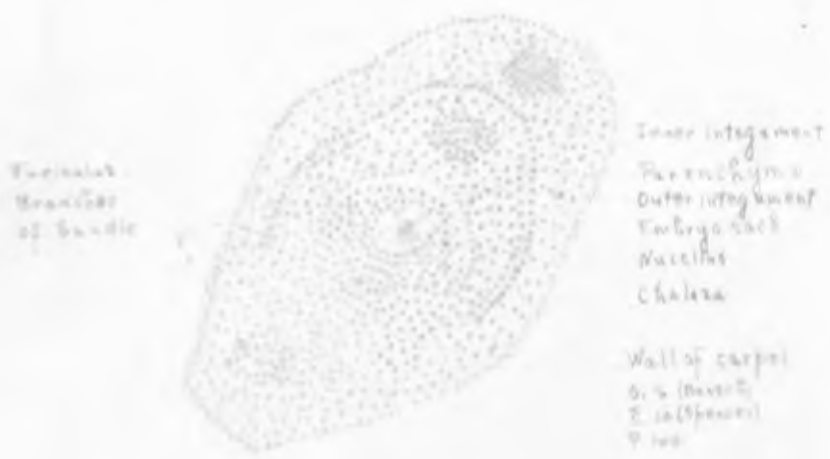
7-1-1-35-15-1

3/6/18





Anemone patens var. wall-jungii  
 2-1-1918-12-13  
 7/9/18



The inside of a bundle on the carpel (cross section)  
 partly diagrammatic

Fig 2

*Anemone patens* var. *wolfgangiana*  
7-2-1-7-15-1  
2/4/12

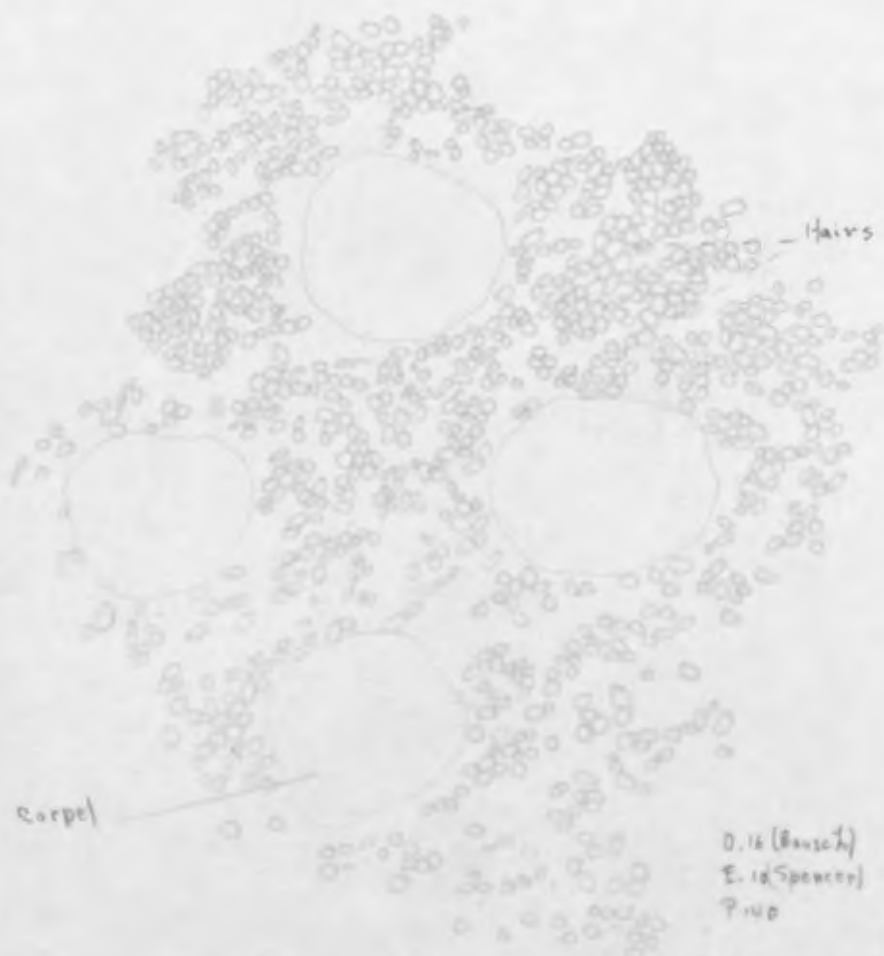
Hairs

Carpel

O. 16 (Bausi &)  
E. 10 (Spencer)  
R. 100

A longitudinal section thro' a dense tangle of hairs and several carpels  
Fig. 9

*Anemone patens* var. *wolfgangiana*  
9-1-1-26-15-3  
5/4/18



D. 16 (Bausch)  
E. 14 (Spencer)  
P. 100

♀ Cross-section of a mass of hairs and several carpels (*Anemone patens*)  
Fig. 10

*Anemone patens* var. *wolfgangiana*

9-1-1-25-15-1

4/27/18



The course of a bundle in the stamen

Fig 11.

Branch to style - - - - -

Trichomes - - - - -

Branches to inner integument and ovule

Branch leading to ovule and style

Vein from receptacle

Branch to style

Branch leading to ovule

Branches to outer integument

O 15m

E 2 x

P. 140m.

4 single carpel  
(diagrammatic  
with case here)

